UTILITY PATENT APPLICATION TRANSMITTAL

Submit an original and a duplicate for fee processing

(Only for new nonprovisional applications under 37 CFR §1.53(b))

ADDRESS TO:

Assistant Commissioner for Patents
Box Patent Application
Washington, D.C. 20231

Attorney Docket No. 400880

First Named Inventor YU et al.

APPLICATION ELEMENTS

1. ☒ Transmittal Form ☐ with Fee
2. ☒ Specification (including claims and abstract) [Total Pages 14]
3. ☒ Drawings [Total Sheets 6]
4. ☐ Combined Declaration and Power of Attorney [Total Pages]
   - a. ☐ Newly executed
   - b. ☐ Copy from prior application **[Note Box 5 below]**
     - i. ☐ Deletion of Inventor(s) Signed statement attached deleting inventor(s) named in the prior application
5. ☐ Incorporation by Reference: The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ☐ Microfiche Computer Program
7. ☐ Nucleotide and/or Amino Acid Sequence Submission
   - a. ☐ Computer Readable Copy
   - b. ☐ Paper Copy
   - c. ☐ Statement verifying above copies

ACCOMPANYING APPLICATION PARTS

8. ☐ Assignment Papers (cover sheet and document(s))
9. ☐ Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☐ Information Disclosure Statement (IDS)
    - ☐ Form PTO-1449
    - ☐ Copies of References
12. ☒ Preliminary Amendment
13. ☒ Return Receipt Postcard (Should be specifically itemized)
14. ☐ Small Entity Statement(s)
    - ☐ Enclosed
    - ☐ Statement filed in prior application; status still proper and desired
15. ☐ Certified Copy of Priority Document(s)
16. ☒ PrintEFS printout
17. ☐ Other:

18. **If a CONTINUING APPLICATION**, check appropriate box and supply the requisite information in (a) and (b) below:
    (a) ☐ Continuation ☐ Divisional ☐ Continuation-in-part of prior application Serial No. .
    Prior application information: Examiner ; Art Unit:
    (b) Preliminary Amendment: Relate Back - 35 USC §120. The Commissioner is requested to amend the specification by inserting the following sentence before the first line:
    "This is a ☐ continuation ☐ divisional of copending application(s)
    ☐ Application No. , filed on .
    ☐ International Application , filed on , and which designates the U.S."

APPLICATION FEES

BASIC FEE				$710.00
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total Claims	4 -20=	0	x $18.00	$0.00
Independent Claims	1 - 3=	0	x $80.00	$0.00
☐ Multiple Dependent Claims(s) if applicable			+$270.00	$
			Total of above calculations =	$
			Reduction by 50% for filing by small entity =	$( )
☐ Assignment fee if applicable			+ $40.00	$
			TOTAL =	$

UTILITY PATENT APPLICATION TRANSMITTAL

Attorney Docket No. 400880

23. CORRESPONDENCE ADDRESS	
23548 PATENT TRADEMARK OFFICE	
Name	Jeffrey A. Wyand; Reg. No. 29,458
Signature	
Date	October 10, 2000

ApTml (Rev. 5/3/2000)

INVENTOR INFORMATION

Inventor One Given Name:: Wing Man
Family Name:: YU
Postal Address Line One:: c/o The Hong Kong Polytechnic University
Postal Address Line Two:: Hung Hom
City:: Kowloon
Country:: Hong Kong
Inventor Two Given Name:: Keng Po
Family Name:: NG
Postal Address Line One:: c/o The Hong Kong Polytechnic University
Postal Address Line Two:: Hung Hom
City:: Kowloon
Country:: Hong Kong
Inventor Three Given Name:: Man Chi
Family Name:: YAN
Postal Address Line One:: c/o The Hong Kong Polytechnic University
Postal Address Line Two:: Hung Hom
City:: Kowloon
Country:: Hong Kong
Inventor Four Given Name:: Hong Bo
Family Name:: GU
Postal Address Line One:: c/o The Hong Kong Polytechnic University
Postal Address Line Two:: Hung Hom
City:: Kowloon
Country:: Hong Kong

CORRESPONDENCE INFORMATION

Correspondence Customer Number:: 23548

APPLICATION INFORMATION

Title Line One:: BODY SCANNER
Total Drawing Sheets:: 6
Formal Drawings?:: Yes
Application Type:: Utility
Docket Number:: 400880
Secrecy Order in Parent Appl.?:: No

Source:: PrintEFS Version 1.0.1

PATENT
Attorney Docket No. 400880

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

YU et al.

Art Unit: Unknown

Application No.: Unassigned

Examiner: Unassigned

Filed: October 10, 2000

For: BODY SCANNER

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to the examination of the above-identified patent application, please enter the following amendments and consider the following remarks.

IN THE SPECIFICATION:

Page 1, line 2, insert the following subheading --Field of the Invention--;

line 4, insert the following subheading --Background--;

line 10, change "technique" to --techniques--;

line 15, after "compact" insert --,--;

line 16, after "cost" insert --,--;

after "require" insert --a--;

line 24, insert the following subheading --Summary of the Invention--.

Page 3, before line 1 insert the following heading --Brief Description of Drawings--;

line 2, change "not" to --now--;

line 16, insert the following heading --Detailed Description--;

line 20, after "distance," insert --in a--;

after "duration" insert --,--;

after "and" insert --that are--;

line 21, after "weight," insert --and--.

Page 4, line 1, change "by" to --from--;

line 3, change "by" to --with--;

line 12, after "is" insert --,--;

after "however" insert --,--;

line 14, change "with" to --in the--;

line 16, after "distance" insert --,--;

line 17, after "2)" insert --,--;

after "quickly" insert --,--;

line 23, change "the" to --a--.

Page 5, line 4, after "microns" insert --thick--;

line 10, change "dimension" to --dimensions--.

Page 6, line 14, change "unparalleled" to --non-parallel--;

change "ray" to --rays--;

line 23, change "equal" to --equally--;

line 24, change "space of" to --spaced--.

Page 7, line 5, delete "images of";

change "pass" to --image passes--;

line 11, change "lens" to --lenses--;

line 24, after "within" insert --a--.

Page 8, line 2, change "a" to --the--;

line 3, delete "common";

line 5, delete "pieces of";

line 6, change "equal" to --equally--;

line 16, change "object" to --objective--;

after "receive" insert --the--;

line 21, change "charge-couple" to --charge coupled--.

Page 9, line 8, change "a piece of" to --an--;

line 10, change "ultra-voilet" to --ultra-violet--;

after "light" insert --,--;

line 13, change "prevents" to --prevent--;

lines 18-19, change "honey cone" to --honeycomb--;

line 20, change "opaquacity" to --opacity--.

Page 10, line 8, change "Flash" to --A flash--;

line 9, change "produce" to --produces--;

line 14, delete "which";

line 25, delete "The";

after "Figure" insert --4--;

line 28, change "convectors" to --converters--.

Page 11, line 5, change "potable" to --portable--;

lines 7-8, delete ", say".

IN THE CLAIMS:

1. (Amended) A compact moiré effect body scanner for generating 3-D images, the scanner including:

an elongate projection module having a light source,

a first [objection] objective lens for directing a beam of light from the source along a first central longitudinal axis,

a first photographic grid for the beam of light and mounted in a plane at right angles to the first central axis to [allow light to] illuminate a body to be scanned, and

an elongate imaging module adjacent the elongate projection module, having a second central longitudinal axis parallel to the first central axis, the imaging module incorporating

a second objective lens for receiving reflected light from the body,

a second photograph grid for the reflected light and mounted in a plane at right angles to the second central axis, and [an]

imaging means for recording [the reflected] a deformed grating image reflected from the body and captured beyond the second photographic grid.

Claim 2 (Amended), line 1, change "A" to --The--.

3. (Amended) [A] The compact moiré effect body scanner according to Claim 1 [or 2], in which the first and second objective lenses have the same focal length and are mounted in a [same] common plane.

4. (Amended) [A] The compact moiré body scanner according to [any of Claims] Claim 1 [to 3], in which nodal points of the [two] first and second objective lenses are separated by [the same distance] identical distances from the respective photographic grids.

Please add the following claims:

5. The compact moiré effect body scanner according to Claim 2, in which the first and second objective lenses have the same focal length and are mounted in a common plane.

6. The compact moiré body scanner according to Claim 2, in which nodal points of the first and second objective lenses are separated by identical distances from the respective photographic grids.

7. The compact moiré body scanner according to Claim 3, in which nodal points of the first and second objective lenses are separated by identical distances from the respective photographic grids.

8. The compact moiré body scanner according to Claim 5, in which nodal points of the first and second objective lenses are separated by identical distances from the respective photographic grids.

<u>IN THE ABSTRACT</u>:

Please replace the existing Abstract with the appended Abstract of the Disclosure.

REMARKS

The foregoing Amendment improves the form of the application without adding new matter.

Respectfully submitted,

LEYDIG, VOIT & MAYER

Jeffrey A. Wyand
Registration No. 29,458

Suite 300
700 Thirteenth Street, N.W.
Washington, D.C. 20005
Telephone: (202) 737-6770
Facsimile: (202) 737-6776
Date: October 10, 2003
JAW:ves

ABSTRACT OF THE DISCLOSURE

A compact moiré effect body scanner provides 3-D images of a human body for use in making up suitable garments. The scanner includes an elongate projection module with a photographic grid that illuminates the body. An elongate imaging module having a second photographic grid lies alongside the projection module and a digital camera is used to capture images of the body. The scanner is typically about 400 mm long, 400 mm high, and 150 mm wide and can be used in normal room light conditions.

BODY SCANNER

The invention relates to body scanners.

The invention relates more particularly to photographic body scanners that are capable of forming images or records of a body for use in making up suitable garments. Such records may be used in other fields such a surgery or pathology where 3-dimensional information is required. Although various imaging technique are known using laser sources and mechanical plotting of images, the present invention is directed to scanners that incorporate projection moiré topography where we have now been found it possible to create scanner systems that are physically compact relatively low in cost and require short scanning distance.

Although various non-contact imaging techniques are known which use a laser or infrared light source, they require time to move the sensors to scan a human body, which also affects the data accuracy. Laser strobe or invisible light spectrum radiation may also cause harm to human eyes and organs.

It is an object of the invention to overcome or at least reduce these problems.

According to the invention there is provided a compact

moiré effect body scanner for generating 3-D images, the scanner including an elongate projection module having a light source, a first objection lens for directing a beam of light from the source along a first central longitudinal axis, a first photographic grid for the beam of light and mounted in a plane at right angles to the first central axis to allow light to illuminate a body to be scanned, and an elongate imaging module adjacent the projection module having a second central longitudinal axis parallel to the first central axis, the imaging module incorporating a second objective lens for receiving reflected from the body, a second photograph grid for the reflected light and mounted in a plane at right angles to the second central axis, and an imaging means for recording the reflected deformed grating from the body captured beyond the second photographic grid.

The imaging means is preferably a digital camera.

The first and second objective lenses preferably have the same focal length and are mounted in a same common plane.

Nodal points of the two objective lenses preferably are separated by the same distance from the respective photographic grids.

A compact moiré effect body scanner according to the invention will not be described by way or example with reference to the accompanying drawings in which:-

Figures 1A, 1B, and 1C are moiré contour pattern images of a front, side and rear view of a human torso;

Figure 2 is a schematic view of a set-up of the scanner to images of a human body;

Figure 3 shows typical high density parallel equal spatial gratings for use in the scanner, and

Figure 4 is a schematic layout showing components of the scanner.

Embodiments of the invention comprise a compact design of photographic 3D scanners that are capable of forming accurate moiré topographic images from a human body surface at short distance, short duration and light-weight, low-cost for use in making perfect fit garments. Such records may be used in other fields, such as surgery or pathology where three-dimensional information is required.

The embodiments of the present invention comprise scanners that modify a technique of projection moiré topography. The basic technique uses optical

interference that occurs by two identical high-density gratings. When the reference grating is projected onto the surface of human body by an objective lens, its varying dimension will deform the grid line shadow. This deformed style of grating is then reflected and captured by another identical objective lens simultaneously. When the deformed reference grating passes through the parallel detection grating, the relative displacements of one grating with respect to the other is provided. (see Figures 1A, 1B and 1C)

It is however possible for embodiments of the present invention to operate under normal light conditions. High-speed pulse light with visible spectrum is used as a safe light source. The scanner system can capture 3D human body images from a short distance up to 0.8 meters (see Figure 2) quickly within 1/1500 second. The scanner is physically compact, light weight and relatively low in cost. Such a design, of a high speed and high quality moiré compact scanner, fulfills the contemporary market requirement. Short focal length objective lenses are used to cover a wider projection area of the field up to 1109.94mm vertical and 924.95mm horizontal at a 1200mm distance. The coverage at 800mm distance is 721.74mm vertical and 601.45mm horizontal.

A high density parallel grating (see Figure 3) is made by using Kodak type #160-01 special glass plate, in

order to avoid optical aberration and high light-diffraction factor due to the wide angle of light rays and adjacency of a rear nodal point. Since a light sensitive emulsion layer is less than 5 microns, it decreases the optical diffraction rate and increases the resolution and contrast of the moiré contour; this improves sharpness around edges of images. The emulsion is coated on a quality soda lime type optical flat glass base. It is therefore a highly transparent optical glass exhibiting stable dimension having only 1.5mm thickness. This will increase image quality and ensure data accuracy. To prevent noise resulting from a high fog level index of photographic silver bromide emulsion, a modified photographic film-developing chemical is also applied to achieve a high contrast range of 2.90 at Light Opacity Log E, which produces low fog level and increases the resolution. Multi-coating is used on each air-glass surface with a thickness of 1/4 wavelength of the incident light wave within the visible spectrum. This increases the light transmission and reduces reflection.

A flash unit is used to produce 1600 watt seconds of pulse light in the visible spectrum at 400 to 700 nm as a projection light source. Although the light intensity is powerful, it will not incur any harm to the human body. The image capturing duration takes less than 1/1500 second and so minimizes any adverse effects that

would normally be caused by body movement. A piece of UV heat absorption glass and low pass filter is applied to cut off long wave infrared and to control the light wavelength to within 400 to 700 mm. This is used not only to maintain a higher safety factor, but also reduces chromatic aberration due to the light dispersion of optical glass when a wide range of light wavelength passes through the optics. Another purpose of this heat absorption glass is to prevent changes in the dimension and density of the glass plates, especially for the projection grid.

The design of image optical system that transfers the unparalleled light ray of contour images into the objective lens requires special mention. This is called the "field lens" (optical transfer component) which has an aspherical curved surface to correct some optical aberration such as spherical aberration, barrel or pincushion distortion and field curvature which is caused by the objective lens. The light rays are collected by a group of Fresnel lenses so as to condense the light passing through the photographic grid plane. High-density parallel reference gratings with equal space of lines and gaps are projected onto a human body by the objective lens. The lens aperture is predetermined to produce sufficient depth-of-field to cover a required part of the human body. The reflecting grating image from the body is deformed due to its

varying dimensions and is simultaneously captured by the other objective lens. The gratings have the same lens aperture for obtaining identical depth-of-field, depth-of focus and image magnification as the projection system. The images of deformed grating pass through the detection grid that is located at the focal plane of the image capture objective lens. The optical interference occurs and forms a moiré contour map.

Since the angle of light rays of the contour map from two objective lens are not in a parallel point source condition, the scanner cannot capture the full frame image by using the other objective lens of a digital camera. A group of optical transfer system field lenses would be required in between the detection grid and the objective lens of the digital camera. One surface of the field lens is a spherically designed to balance the spherical aberration and the curvature of field caused by the objective lens, and one surface of the field lens is plano-convex. The function of field lens group is to capture the light rays and refract them as a parallel point source which is well suited to form the full frame image by an objective lens. Finally, the contour image is formed and recorded by the digital camera within short duration of time. A digitized bitstream signal of contour data is provided for image analyses and generation of 3-dimensional data of the human body.

Thus, in the embodiment, the scanner comprises two objective lenses, with a same focal length and optical design, located in parallel in the same common plane. Nodal points of the two lenses are at the same distance from the respective grid planes. Two pieces of high-density grid planes have equal spaced identical black and white photographic glass gratings of a density of 17 line pairs per mm for capturing images from a distance of 800 mm. The two grid planes are placed in parallel behind the objective lenses. One grid or grating is for light projection and the other is for image detection.

Referring to Figure 4, the layout of the scanner shows an objective lens 1 for high-density parallel black and white line grid projection towards the human body. An object lens is arranged to receive deformed grating image reflected from the human body. An optical transfer system 3, 4 changes the light rays from a non-parallel to a parallel form, which is suitable for another objection lens to capture whole images and re-form the images onto a charge-couple device. The optical transfer systems includes two field lenses 3 and 4. The lens 3 is a plano-convex lens made of optical glass with an optical multi-coating (radius = 77.52mm). The lens 4 is a double-convex lens made of PMMA highly transparent optical plastic material; one side of the lens is spherical and the other side is aspherical (respective radius 167.2764mm and 35.21515). Two grid

planes 5 are formed of soda line optical planar glass providing high density black and white grids of high resolution and high contrast and formed with ultra thin chromium emulsion. Both sides of the grid planes are multi-coated.

A double-convex glass condenser 6 has one spherical side and one aspherical side with a piece of optical filter 7 and 8 at each side. The filters 7 and 8 are used for absorbing heat and removing ultra-voilet light respectively. The filters increase resolution of the line grid when it is projected onto the surface of the target and prevents heat energy from changing the dimensions of the glass grid. A planar optical diffusion glass 9 diffuses projected light to prevent hot-spot imaging of a flash tube onto the human body which can be caused by a greater depth of focus when the objective lens works with a small aperture. A honey cone metal screen 10, with 50% light opacity at its central region and 5% opaquacity at its edges, balances out an optical vignette caused by the short focal length objective lens 2. The screen produces a more even illumination of the whole image.

A digital camera 11 has an objective lens 12, which can form a maximum of 1:2 close distance, and a high speed 1/500 second focal plane shutter 13 is used to cut off ambient light. A CCD light sensor 14 is built in at the

focal plane of the camera. Analogue to digital encoders and generator 15 supply signals to a personal computer (PC).

A flash unit includes a cooling fan 16 and a U-shaped flash tube 17. The flash tube has a UV coating which can endure 3200-watt power energy and produce 5600k spectrum light pulses. Flash intensity of 1600 joules produce sufficient light projection with a flash duration of 1/1666 seconds. An optical reflector 18, made of aluminium, collects and diffuses flash light from a 260 degree angle and reflects the flash light to 100 degree front directional. A ceramic lamp base 19 holds the flash tube 17 which and is arranged to receive a power supply via a transformer 20 from DC capacitors 21, 22. There are sixteen capacitors 21 rated at 360V and 1500 microfarads each, and eight capacitors 22 rated at 400 volts and 100 microfarads each. A rectifier circuit 23, limiting resistor 24 and flash trigger circuits 25 complete a power supply circuit for the flash unit. The flash unit is arranged to selectively produce three levels of intensity of light, namely 400, 800 and 1600 watt seconds.

The Figure also shows a flash synchronisation cable 26, a second cooling fan 27, and a cable 28 for delivering bit stream data signals from the analogue to digital convectors 15 to the PC.

The scanner shown in the Figure is typically about 400 mm long, 150 mm wide and 400 mm high and weighs 6.72kg or 8.6kg (incl. Nikon D1 camera) and so is easily potable. As mentioned earlier, the data can be captured in less than 1/1500 second for each exposure in a normal room light environment with 100 to 150 lux illumination, say. It is also not necessary for the subject to 'pose' for extended periods of time in order for the to 'pictures' to be taken.

WE CLAIM:

1. A compact moiré effect body scanner for generating 3-D images, the scanner including an elongate projection module having a light source, a first objection lens for directing a beam of light from the source along a first central longitudinal axis, a first photographic grid for the beam of light and mounted in a plane at right angles to the first central axis to allow light to illuminate a body to be scanned, and an elongate imaging module adjacent the projection module having a second central longitudinal axis parallel to the first central axis, the imaging module incorporating a second objective lens for receiving reflected from the body, a second photograph grid for the reflected light and mounted in a plane at right angles to the second central axis, and an imaging means for recording the reflected deformed grating from the body captured beyond the second photographic grid.

2. A compact moiré effect body scanner according to claim 1, in which the imaging means is a digital camera.

3. A compact moiré effect body scanner according to Claim 1 or 2, in which the first and second objective lenses have the same focal length and are mounted in a same common plane.

4. A compact moiré body scanner according to any of Claims 1 to 3, in which nodal points of the two objective lenses are separated by the same distance from the respective photographic grids.

ABSTRACT (FIGURE 4)

A compact moiré effect body scanner provides 3-D images of a human body for use in making up suitable garments. The scanner includes an elongate projection module with a photographic grid that illuminates the body. An elongate imaging module having a second photographic grid lies alongside the projection module and a digital camera is used to capture images of the body. The scanner is typically about 400 long, 400 high and 150 mm wide and can be used in normal room light conditions.

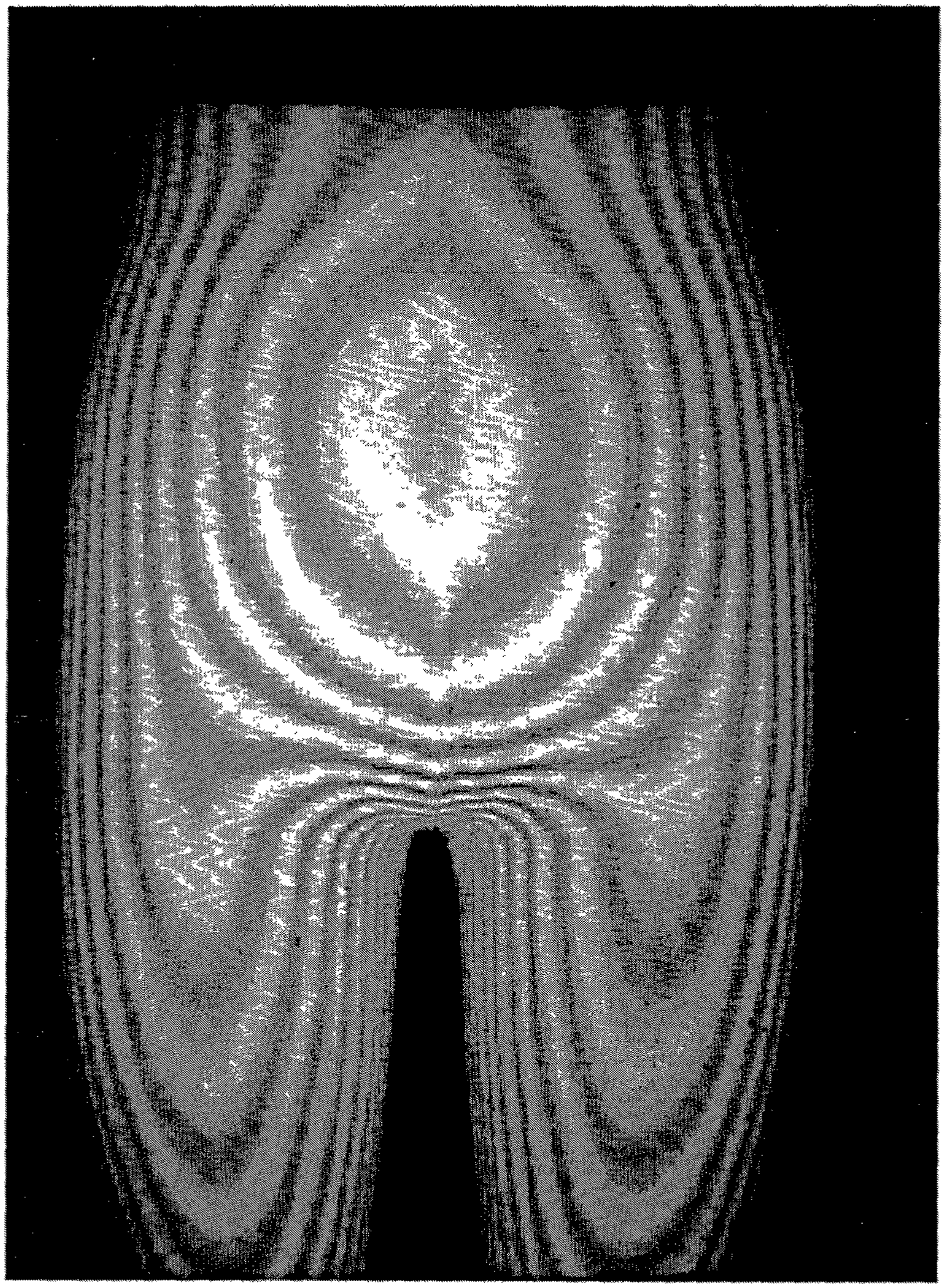

Figure 1A

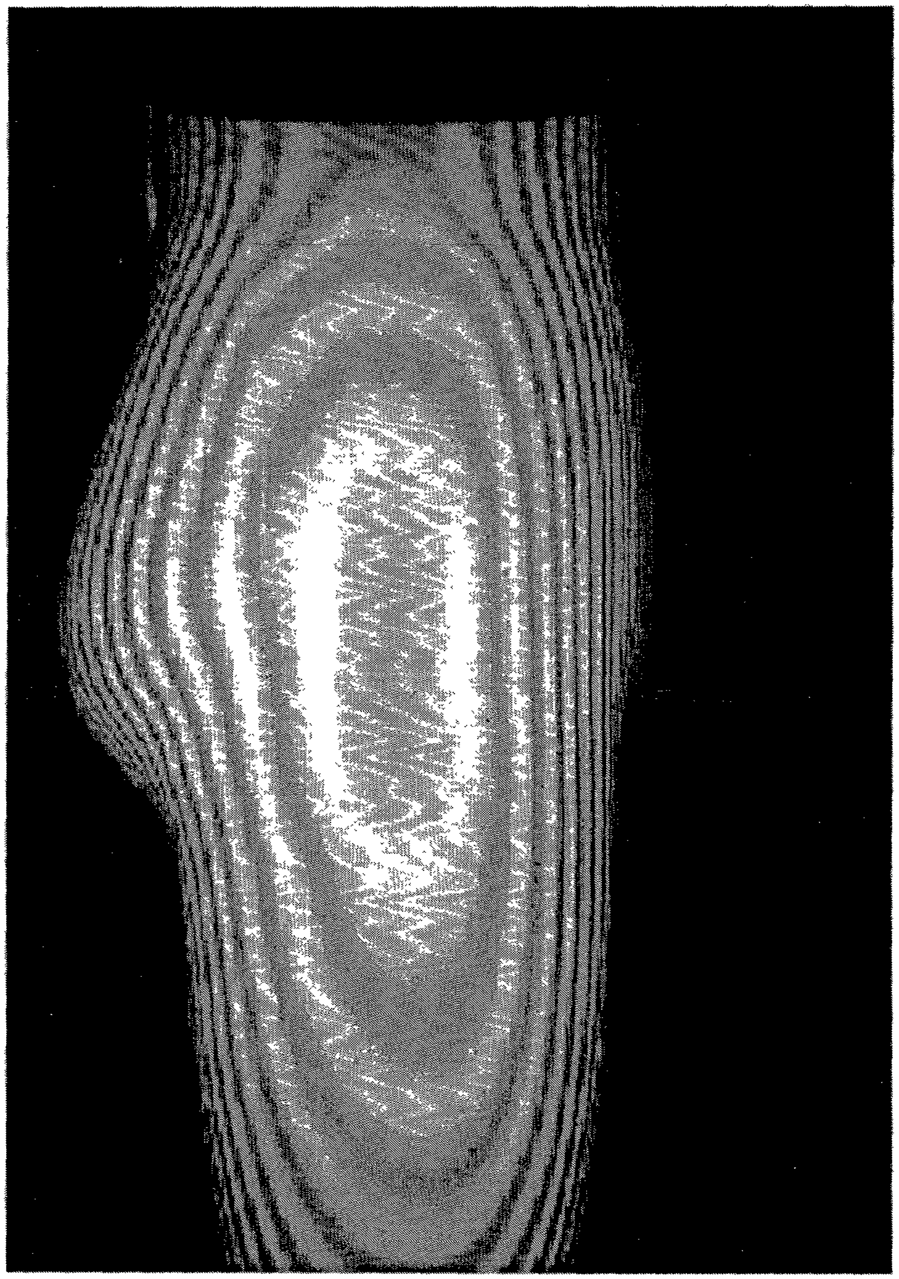

Figure 1B

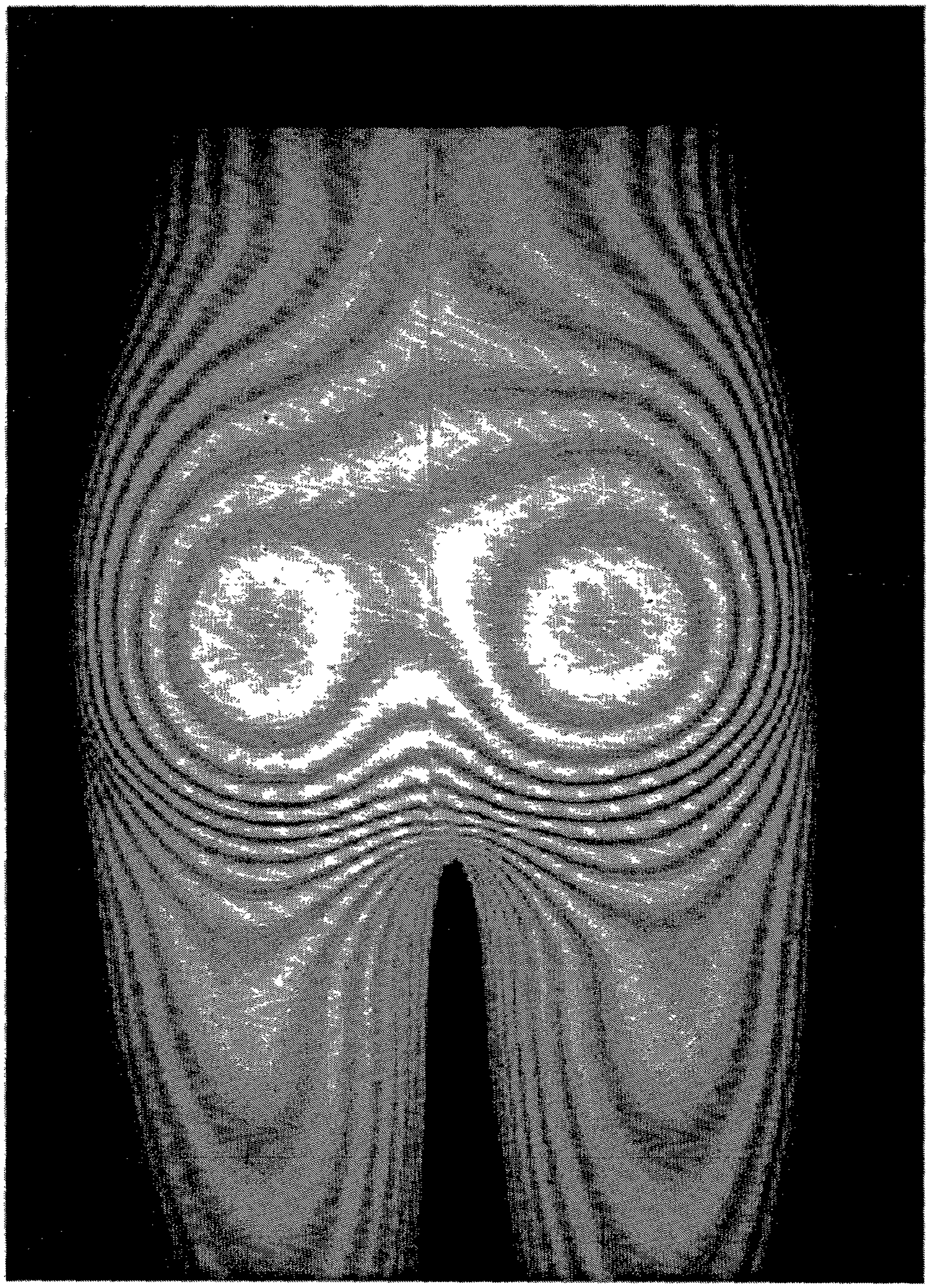

Figure 1C

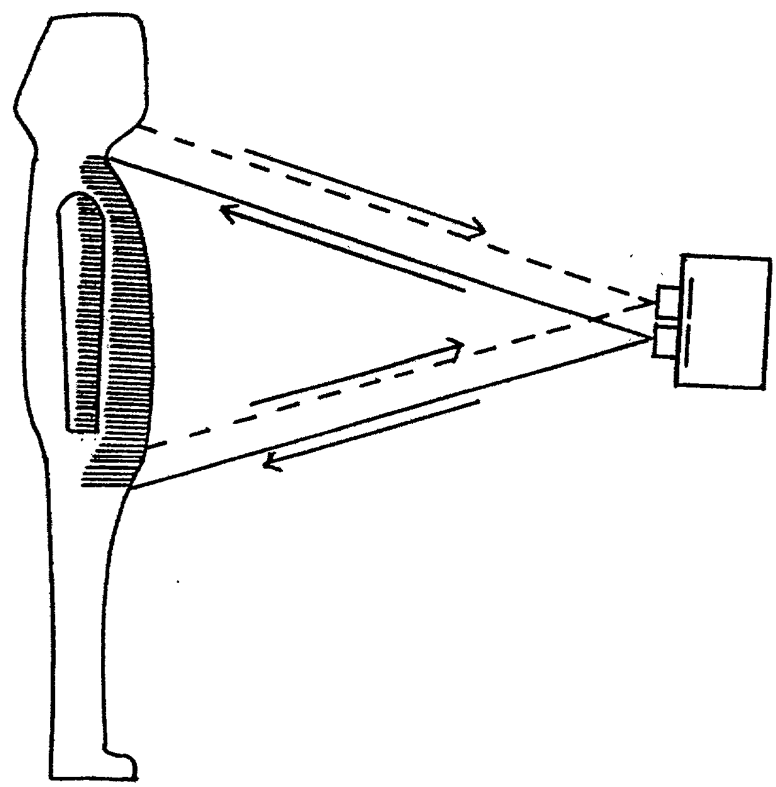

Figure 2

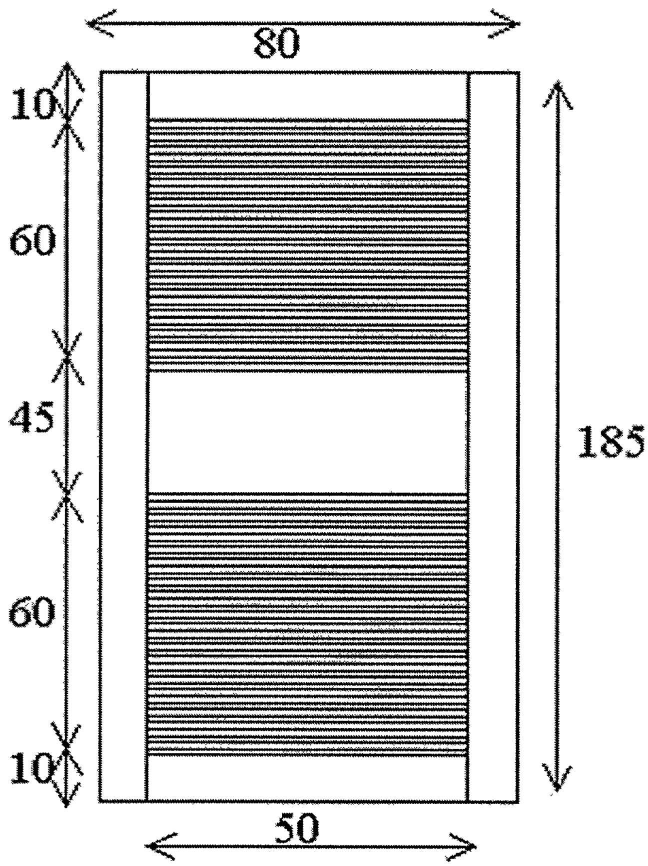

Figure 3

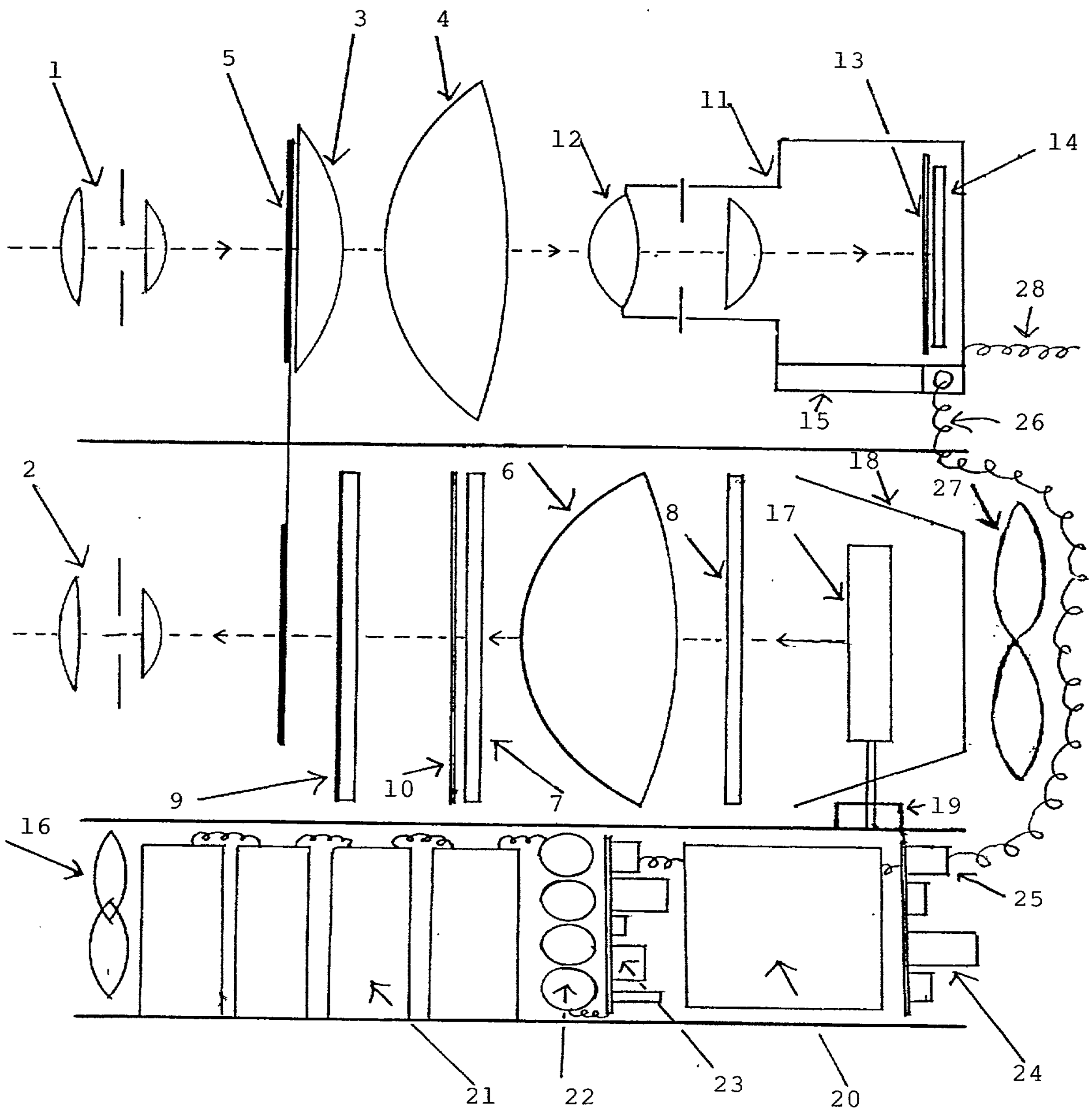

Figure 4